# CHAPTER 7: AIR AND ENVIRONMENT

| Key words | Learning Outcomes (LO) |
|---|---|
| Air<br>Air pollution<br>Burning<br>Rusting (corrosion)<br>Oxides | By the end of this chapter, you should be able to:<br>a) Understand that air is a mixture of different gases that can be separated and used.<br>b) Understand how air pollution can affect the atmospheres.<br>c) Understand and appreciate that processes such as burning and rusting (corrosion) use oxygen from air to form oxides |

**COMPETENCY:**
The learner appreciates that air is a mixture of gases in which oxygen is the active constituent, and he/she can describe processes that may affect air quality.

## 7.1. Introduction:

The space above the Earth's surface is called the atmosphere. The planet Earth unlike other planets provides a conducive natural world composed of both visible and invisible particles. The invisible particles are mainly air particles, particles that you cannot see with your naked eyes, because they are smaller than grains of dust. Whenever you breathe in, you take in oxygen and you take out carbon dioxide. This provides evidence that gas particles really exist around us.

## 7.2. Air as a Mixture:

Air is a mixture of different gases that make up the atmosphere. It may also contain other particles such as dust particles, nitrogen oxides, sulphur dioxide and carbon monoxide gas. Air constitutes mainly of nitrogen, oxygen, carbon dioxide, water vapour, and noble gases (such as argon, neon, helium, xenon and krypton)

**Percentage composition of different gases in the air**

**ACTIVITY:7.2(a)**

**What you need:**

Access to reference textbooks, or internet.

**What to do:**

In groups, carryout research to find out the percentage composition of each gas component in the air using a referent textbook, or internet. Share your findings with the rest of the class.

| Gas component | Percentage composition by volume |
|---|---|
| Nitrogen | |
| Oxygen | |
| Carbon dioxide | |
| Rare (Noble) gases | |
| Water vapour | It varies from place to place |

**Percentage composition of a gas from a pie chart:**

**ACTIVITY:7.2(b)**

**What you need:**

A pair of compasses, a protractor, a pencil

| Gas component | Degree of a gas |
|---|---|
| Nitrogen | **280.8º** |
| Oxygen | **75.6º** |
| Carbon dioxide | **0.1º** |
| Noble gases | **3.5º** |

**What to do:**

1) Individually, draw a pie chart using a pair of compasses and a pencil.
2) Using a protractor, and a pair of compasses, calculate the degree of angles of each gas has when drawn on a pie chart. Use the table above.
3) Use your pie chart to calculate the percentage of each gas occupies as drawn from the pie chart.

**Separation of gaseous components of air**

Air contains some useful gases such as nitrogen, oxygen that very important in today's activities. They are industrially obtained from the air.

**How different gas components can be separated from air.**

The industrial separation of the different components of air occurs in four different stages:

**Stage 1: Filtration and Purification**

Atmospheric air is pumped into the **filters** and **purifiers**, to remove dust particles present in the air.

**Stage 2: Absorption**

The dust free air is allowed to pass through absorption chemicals such as sodium hydroxide solution to absorb carbon dioxide from the air and through silica gel to remove moisture.

**Stage 3: Liquefaction of air**

The remaining gas components (nitrogen, oxygen and argon) is then compressed at high pressures of about 100 atmospheres and then cooled to low temperatures of -200$^{o}$C forming liquid air.

**Stage 4: Fractional distillation:**

The liquid air is then allowed to pass through a fractionating column, where fractional distillation takes place. Nitrogen comes out first as distillate at -196$^{o}$C followed by Argon at -186$^{o}$C and lastly oxygen at -183$^{o}$C

**ACTIVITY:7.2(c)**

**What to do**

In groups, observe the table below and use it to answer the questions that follow.

| Liquid air | Composition of each fraction |
|---|---|
| **Nitrogen** | -196°C |
| **Argon** | -186°C |
| **Oxygen** | -183°C |

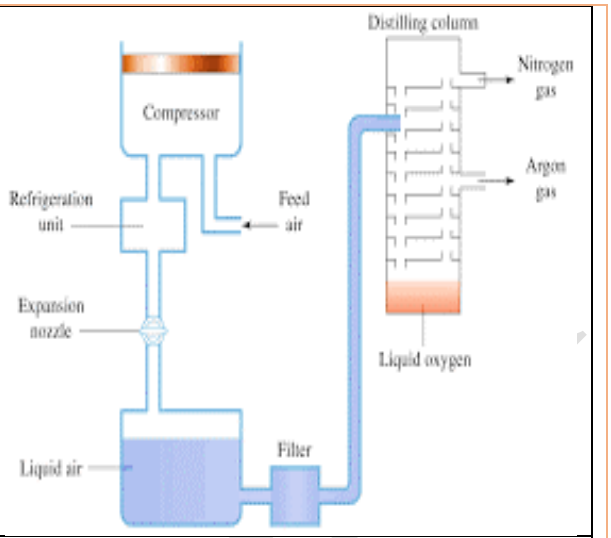
**Discussion Questions:**

a) Identify which components of liquid air distils first from the following pairs.

(i)Liquid nitrogen and oxygen

(ii)Liquid nitrogen and argon

b) Give a reason for your answer in (a)




c)Name the method of separation of liquid air. What is the principle behind the method?

d)Explain why the following were carried out during the separation of gas components from air.

(i)Air filtered and purified.

(ii)Air passed through sodium hydroxide solution and silica gel.

(iii)Air was liquefied.

(iv)Air passed through fractionating column

**Air is a mixture NOT a compound**

| Air as a mixture | A compound |
|---|---|
| Has variable composition of gases | Has a fixed composition |
| Has no fixed ratio | Has fixed ratio |
| Has no chemical bond | Has chemical bond |
| Can be separated by physical means only | Can be separated by chemical means only |

**Uses of the different components of air:**

**a) Uses of Oxygen gas**

-Aero planes, astronauts, and sea divers, carry oxygen gas cylinders in places of limited oxygen supply to support normal breathing.

-Patients in ICU with breathing related problems are provided with oxygen through oxygen masks to save life.

-Oxygen gas mixed with acetylene gas ($C_2H_2$) is used as oxy – acetylene flames for cutting and welding metals. It produces heat of about 6000°C that cut and melt steel metals whose melting point is about 3000°C; hence it is very hot.

**b) Uses of Nitrogen gas:**

-Liquid nitrogen being very cold at -196°C can be used to preserve food stuffs in food factories. Preserve and store tissues and organ samples from microbial invasion.

**c)Uses of Noble gases**

-Neon is used in advertising signs due to its ability to glow red – orange light when a current is passed through it.

-Argon is used in fluorescent tubes to create a stable and consistent glow light.

-Xenon is used in high – light – intensity discharge lamps used in automotive headlights and movie projectors.

-Argon is commonly used as a preventive gas in welding processes. It acts as an inert medium to protect the welded areas from reacting with atmospheric gases

**d)Uses of Carbon dioxide gas:**

-Carbon dioxide is used as a preservative in the food industry. It aims at extending the life – span of perishable foods by inhibiting the growth of bacteria and molds

-Carbon dioxide is used as fire extinguishing agent especially where water – based extinguishers could damage sensitive equipment, such as electric or computer rooms

-Dry ice carbon dioxide is extremely cold (it freezes at-78.5$^0$C and sublimes into gas) upon gaining enough heat. This makes it suitably used as refrigerant for cooling foods and drinks.

-Carbon dioxide is used in bread and cake baking. It makes the dough to rise and expand.

-Carbon dioxide is a raw material used by green plants to make their own food through photosynthesis.

**7.3. Air pollution**

**Air pollution**: The release of harmful gases and particles into the atmosphere, affecting air quality and human well- being.

**Sources, causes, effects and measures of air pollution**

| Pollutant | Source | Effects | Measures taken |
|---|---|---|---|
| **Carbon monoxide gas** | Industries Automobiles | Burning of coal, petroleum fuels, produces carbon monoxide as greenhouse gas that causes global warming | Encouraging the use of renewable energy fuels such as solar, hydro-electric power, geothermal, biomass |
| **Sulphur dioxide gas** | Industries | Burning of coals produces sulphur dioxide gas that forms acid rain affecting buildings and soil pH | -Encouraging the use of fuel gas desulphurization system, to remove sulphur dioxide gas.<br>-Encouraging the use of slake lime calcium hydroxide to remove sulphur dioxide gas |
| **Nitrogen oxides** | Industries Automobiles | Burning of coal and petroleum oil, produces nitrogen dioxide gas and nitrogen monoxide gas as greenhouse gases that causes global warming | Encouraging the use of selective catalytic converter systems to reduce nitrogen oxides and carbon monoxide gas emission from the industries and automobiles |
| **Dust storm** | Roads, mining, construction sites | Affect the air quality lowering efficiency in breathing and vision. | Watering and moisture control method, to suppress dust particles |
| **Particulate matter** | Industries Automobiles | Forms solid particles and liquid droplets in air that reduces the clarity of air and vision | Encouraging the use of renewable fuel energy, electrostatic precipitators |

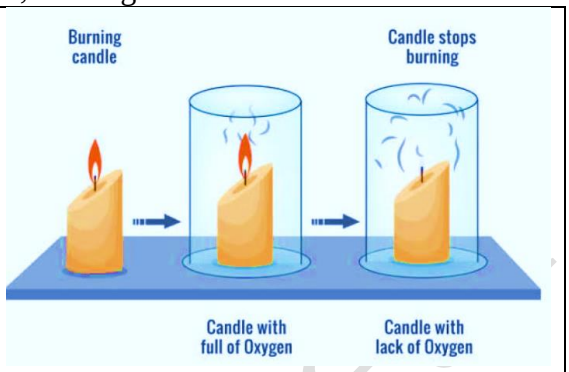
**7.4. Oxygen as the active ingredient of air.**

**ACTIVITY:7.4(a)**

**What you need:**
Candle wax, a light source, plasticine, glass beaker, watch glass.

**What to do:**
In groups, **carryout investigation to find out the active components of air that supports and extinguishes burning of candle wax**

1. Place a candle wax on watch glass and light it using a matchstick.
2. Invert the glass beaker over the burning candle as shown in the *figure 7.5(a).*
3. Using plasticine, wrap it around the beaker and watch glass, to block the incoming air.




**Discussion Questions**
a)Name the gas component that:
(i)Supported burning of candle wax. (ii)Extinguished burning of candle wax.

**ACTIVITY:7.4(b)**
**What you need**
A trough, glass jar, a beehive shelf, sodium hydroxide solution, a candle wax, a long ruler and a match box.
**What to do:**
In groups, carryout investigation to determine the percentage of the active gas used when candle wax burns.

1. Put dilute sodium hydroxide solution into a trough to about three quarter full.
2. Place the candle wax to on a candle stand using some molten candle wax.
3. Immerse the beehive self into the sodium hydroxide solution. Ensure that it is fully covered by the solution.
4. Invert a gas jar over the candle. Measure and record the height ($H_1$) of air between the surface of the solution and air gap in the gas jar as shown in fig7.4(a). Use the long ruler.
5. Remove the gas jar. Light the candle and immediately cover it with the gas jar as shown in fig 7.4(b)
6. Observe what happens. Allow the set – up apparatus to cool down then measure the final height of the air column ($H_2$) after the candle goes off.
7. Record your findings of the observations in the table below. (*Fig 7.4(a) & 7.4(b)*

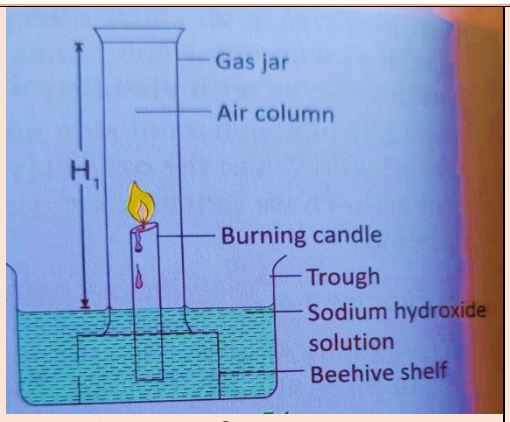



**Fig 7.4(a) Start of Experiment**

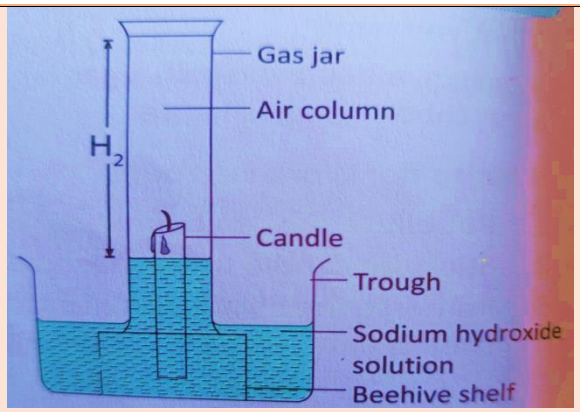



**Fig 7.4(b) End of Experiment**

**Height of the air column:**

| (i) Before lighting candle wax (cm) | (ii) After the candle light goes off (cm) | (iii) Difference of air column used [$H_1$ - $H_2$] (cm) |
|---|---|---|
| | | |

**Discussion Questions:**

a) Name the:

(i) Active gas that supported burning of candle wax.

(ii) Gas that put out burning of candle wax.

b) Determine the percentage by volume of the active has used in the air when candle wax was burnt. Use, percentage of active gas = $\frac{H1 \quad -H2}{H1}$ **x 100%**

c) Use the value obtained from (b) to determine the percentage of the inactive part of air.

d) Name the inactive gas present in the air.

e) Suggest:

(i) with reason(s) why the volume of sodium hydroxide solution was varying.

(ii) why sodium hydroxide solution was preferred to water in this experiment.

## 7.5. Oxygen combining with elements

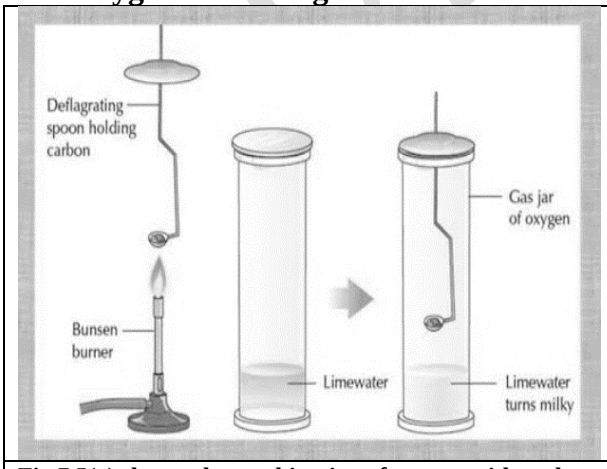



**Fig 7.5(a) shows the combination of oxygen with carbon**

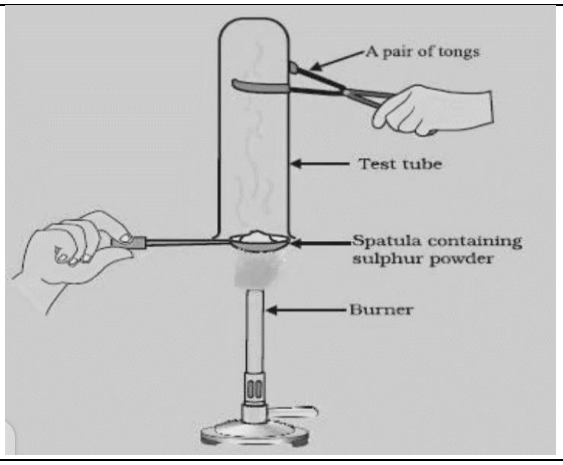



**Fig 7.5(b) shows oxygen combining with sulphur**

**ACTIVITY:7.5(a)**

**What you need:**
Spatula, sodium, magnesium ribbon, sulphur, carbon (powder charcoal), deflagrating spoon and heat source.

**What to do:**

**Experiment ONE:**

1. Put a small piece of sulphur in a deflagrating spoon. Put wet litmus paper close to the spoon. Make your observation.
2. Heat it using a Bunsen burner flame.
3. Repeat the procedures 1 and 2 using carbon and sodium element. Leave the product to cool and then drop a wet litmus paper, and leave it stand. Make your observation.
4. Record all your observations in the Table of results below.

| Element | Flame colour | Appearance of wet litmus paper | Name of the oxides |
|---|---|---|---|
| Sulphur | | | |
| Sodium | | | |
| Carbon | | | |
| Magnesium | | | |

**Did you discover:**

**7.6. Writing word Equations:**

It involves two sides, the Left – Hand Side [LHS] and Right – Hand Side [RHS]. The LHS represents the **reactants** and RHS represents the **products**. The use of arrow (⟶) represents **chemical reaction**.

Reactants ⟶ Products

**Examples**:

Carbon + Oxygen ⟶ Carbon dioxide

Carbon + Oxygen ⟶ Carbon monoxide

**ACTIVITY:7.6(a)**

**What to do:**

In groups, write the following word equations for the following chemical reactions. Share and compare your findings with the rest of the class.

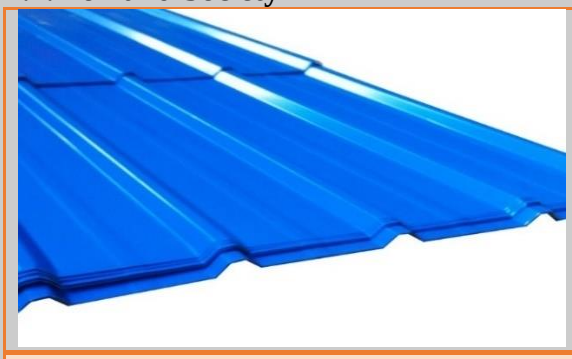
**Task**:

1. Write word equations for the following reactions leading to the formation of oxides.

a) Sulphur burns in oxygen to form sulphur dioxide.
b) Potassium burns in oxygen to form potassium oxide.
c) Aluminium burns in oxygen to form aluminium oxide.
d) Calcium burns in oxygen to form calcium oxide.
e) Carbon burns in limited oxygen to form carbon monoxide.
f) Nitrogen burns in excess oxygen to form nitrogen dioxide.
g) Carbon burns in excess oxygen to form carbon dioxide.
h) Sodium burns in excess oxygen to form sodium peroxide.
i) Nitrogen burns in limited oxygen to form nitrogen monoxide.
j) Magnesium reacts with oxygen forming magnesium oxide.
k) Sodium reacts with water to form sodium hydroxide and hydrogen gas.
l) Calcium reacts with water to form calcium hydroxide and hydrogen gas.

m) Magnesium reacts with steam to form magnesium oxide and hydrogen gas

**7.7.Iron and Society**



**Iron sheet**

**Iron rust**

**Rusting** is the process by which iron metal develops reddish brown coating in the presence of oxygen and moisture. The reddish-brown substance is called **rust**.

**Rust** is the development of a reddish-brown substance on iron metal in the presence of oxygen and moisture.

**The necessary conditions for rust to take place on iron materials**

-Presence of Moisture (water) and Oxygen.

The absence of any one conditions, no rusting occurs on the iron materials, hence rusting only takes place in the presence of both oxygen and moisture.

**Scientific investigation on the factors affecting rusting of iron materials**

**ACTIVITY:7.7(a)**

Plan an investigation to determine the factors that affect the rusting of iron materials that is known to be the common problems in most roofings made of iron metals.

**Task**:

Write a descriptive report about your findings including the following.

(i) Aim of the experiment.
(ii) Variables of the experiment.
(iii) Hypothesis of the experiment
(iv) List of apparatus and materials to be used.
(v) Procedure of the experiment.
(vi) Observations and conclusion from the experiment.

**Presence of some corrosive substances increases the rates of rusting on iron materials**

**ACTIVITY7.7(b)**

Plan a scientific investigation to determine the factors that increases the rates of rusting of iron materials that is known to be the common problems in most roofings made of iron metals.

You are provided with some liquid substances such as acid solution, salt solution from common salt, and liquid soap solution.

**Task**:

Write a descriptive report about your findings including the following.

(i) Aim of the experiment.
**(ii)** Variables of the experiment.

**(iii)** Hypothesis of the experiment
**(iv)** List of apparatus and materials to be used.
**(v)** Procedure of the experiment.
(vi) Observations and conclusion from the experiment.

**Methods that prevent rust on iron materials**

**ACTIVITY:7.7(c)**

**What to do:**

In groups, research on the role of each of the following methods in controlling rusting of iron materials using reference textbooks. Present and share your findings to the rest of the class. Use the table below:

| Methods | How each method works |
|---|---|
| Oiling and greasing the surface of iron | |
| Using galvanized iron materials | |
| Painting the iron surfaces | |
| Alloying iron materials | |
| Sacrificial protection | |
| Tin and zinc plating of iron materials | |
| Enameling iron materials | |
| Zinc galvanization of iron materials | |
| Tin electroplating | |

**Effects of rust on iron materials**

**7.8.Sample of Activity of Integration**

## 7.9.END OF CHAPTER EXAM QUESTIONS

1. Air is a mixture of gases.

a) Name and state the percentage of two major components of air in the atmosphere
b) Describe two uses of each component of air in (a).
c) The components of air above were compressed to liquid air. They were later separated.
i) Name the method of separation
ii) Give reason for the principle behind the method used.

2. Before the air was compressed into liquid air. It was first cooled down by lowering the temperatures below their boiling points. A mixture of solid air and liquid air were formed.

a) Name the gaseous components present in the:
(i) Solid air. (ii) Liquid air.
b) What name of the method is used to separate:
(i) Solid components of air from liquid air
**(ii)** Gaseous components of liquid air.

3. Polluted air is an unsafe and impure air whereas unpolluted air is a safe and pure air.
a) Define **air pollution**.
b) Name two compounds in:
(i) A safe and pure air. (ii) An unsafe and impure air.
c) Name and explain two human activities that may lead to increased:
(i) Impurities in the atmospheric environment. (ii) Purities in the atmosphere.
d) Name the natural process that:
i) Lowers the level of Oxygen in the atmosphere
ii) Lowers the level of Carbon dioxide in the atmosphere.
(ii) Increases the level of oxygen in the air.
(iii) Increases Carbon dioxide level in the air
4. The corrosion of iron materials is called rusting. It occurs under certain conditions.
a) Define "**rusting**" of iron.
b) Write the:
(i) Chemical name for rust.
(ii) Chemical formula for rust.
c) State the necessary conditions for rusting of iron to take place.
d) Draw labelled diagrams to show that:
(i) Iron nails do not rust in the absence of water vapour.
(ii) Iron nails do not rust absence of oxygen.
(iii) Iron nails rust in the presence of both oxygen and water vapour.
e) Iron rust can be controlled. Explain how each of the following method prevents iron rust. By:
(i) Painting (iii) Tin - plating
(ii) Greasing (iv) Use of galvanized iron.

# CHAPTER 8: WATER

| Key words | Learning Outcomes (LOs) |
|---|---|
| Water<br>Water cycle<br>Water properties<br>Water treatment<br>Sewage treatment | a. Understand the existence of water as a natural resource, its physical and chemical properties. Its importance in everyday life activity<br>b. Appreciate how water is recycled by natural processes.<br>c. Understand the process of water and sewage treatment. |

**COMPETENCY:**
The learner investigates evaporation, and condensation as natural processes, essential for replenishing supplies of fresh water in the water cycle.

## 8.1. Introduction

Water is one of the most successful compounds on the Earth's surface. It covers about 70% of the Earth's surface. It is a compound made of hydrogen and oxygen atoms chemically combined together in fixed ratios.

## 8.2. Existence of water as a natural resource

**Water** is a compound of hydrogen and oxygen only. It exists as matter in all the three states (solid when it is ice, liquid when it is a fluid and a gas when it is vapour). The most common state of water at room temperature is liquid state.

**Sources where water exists include the following**

Well
Sea
Rain
Tap
Canal
River
Tube-well
Stream
Handpump
Tanks

**ACTIVITY:8.2(a)**

**What to do:**

In groups, discuss to identify the sources of **surface** and **underground** water. Share and compare your findings with the rest of other groups on your class.

## 8.3. Physical properties of pure water

**ACTIVTY:8.3(a)**

**What to do:**

In groups identify the physical properties of pure water. Share and compare your findings with the rest of the class. Use the table below.

| Physical properties | Physical behaviors |
|---|---|
| 1) Colour | |
| 2) State at room temperature | |
| 3) Smell/ Odour | |
| 4) Colour changes of litmus paper(s) | |
| 5) Freezing point | |
| 6) Boiling point | |

| | |
|---|---|
| 7) Taste | |
| 8) A universal solvent | |
| 9) Density of water as a liquid and solid substance | |

**8.4. Chemical properties of water**

The presence of some dissolved solutes such as acids, salts, alkalis and metals, changes the chemical composition of water, permanently.

**ACTIVITY:8.4(a)**

**What you need:**

Sodium hydroxide pellets, anhydrous copper (II) sulphate, hydrated sodium carbonate crystals, petri dishes, spatula, labels, test-tube**,** test-tube holder dropper, distilled water, heat source.

**What to do:**

In groups, carryout the following investigations to determine the effect of water as a solvent on some compounds. Share and compare your findings with the rest of the class.

**Treat your experiments as follows:**

| Experiment | Activity |
|---|---|
| **A** | Place few powdery solid of anhydrous copper (II) sulphate into a clean petri dish, then add five drops of water. Make observation. |
| **B** | Place few pellets of sodium hydroxide into a clean petri dish. Leave it to stand for 5 minutes. Make observation. |
| **C** | Put one spatula endful of hydrated sodium carbonate into a dry clean test tube, hold it with a test tube holder. Heat it strongly until there is no further change occur. Make observation.<br>Allow the solid to cool down, then add 3 drops of water, make observation. |

**Discussion Questions:**

**a)** Record your experimental observations made in the table below.

| Experiment | Observation(s) |
|---|---|
| **A** | |
| **B** | |
| **C** | |

**8.5. Terms associated with water:**

a) **Anhydrous compounds:** Are compounds that don't have water of crystallization in their structures.
   **Examples:** anhydrous copper (II) sulphate, anhydrous calcium chloride, anhydrous cobalt (II) chloride, anhydrous sodium carbonate etc.

b) **Hydrated compounds:** Are compounds that have water of crystallization in their structures.
   **Examples:** Hydrated copper (II) sulphate, hydrated cobalt (II) chloride, hydrated sodium carbonate etc.

c) **Water of crystallization:** Refers to the amounts of water molecules that are chemically combined within the structure of a compound.

d) **Deliquescent substances** are compounds which have a strong affinity for water vapour (moisture) in the air and dissolve to form a solution.
**Examples**: caustic potash (potassium hydroxide), caustic soda (sodium hydroxide), ammonium chloride, zinc chloride.

e) **Efflorescent substances** are substances with have strong affinity of giving off their water of crystallization when they are exposed into the atmosphere.
**Examples** hydrated sodium carbonate – 10 – water, hydrated potassium carbonate – 10 – water, hydrated copper (II) sulphate – 5 - water.

**f) Hygroscopic substances:** Are substances which have strong affinity for water vapour in the atmosphere and remain undissolved after absorption of water vapour.
**Examples**: anhydrous calcium chloride, concentrated sulphuric acid. They are used as drying agent during dry gas collection in the laboratory.

## 8.6. Reactions of metals with cold water

It will be remembered that not all metals react with cold water, to form **metal hydroxides** and hydrogen gas.
The metals that react with cold water to form alkaline solution and hydrogen gas include the following, sodium, calcium and potassium metals.
The metals with don't react with cold water, include magnesium, zinc, iron, aluminum, lead, and copper metals.

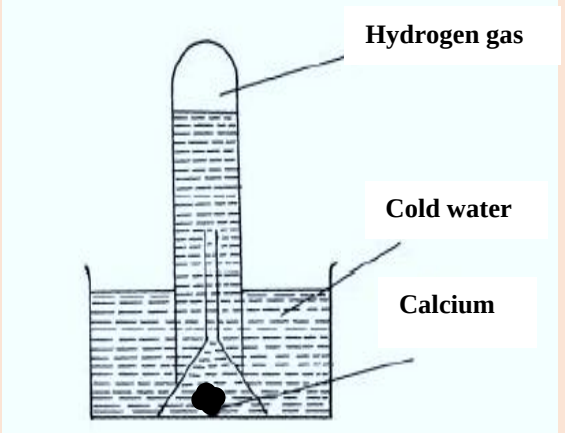



**Fig 8.6(a) Reaction of calcium with cold water**

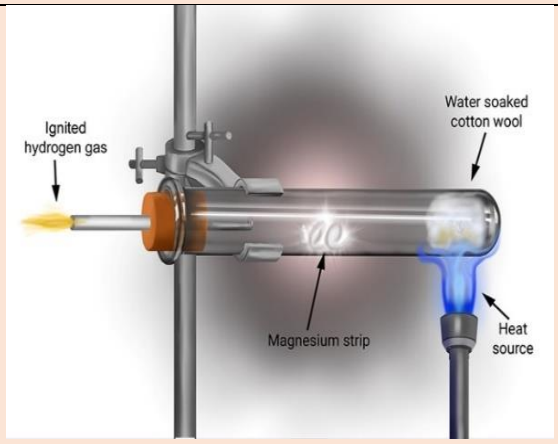



**Fig 8.6(b) Reaction of heated magnesium with steam**

**ACTIVITY:8.6(a)**

**What you need:**

Sodium metal, calcium metal, magnesium ribbon, copper metal, zinc metal, test tubes, heat source, universal indicator, a knife, a funnel, beakers, a pair of tongs, and water.

**What to do:**

In groups, carryout the following investigations to find out the chemical reactions of water with metals under different conditions. Share and compare your findings with the rest of the class.

**Treat your experiments as follows:**

| Experiment | Activity |
|---|---|

| | |
|---|---|
| **A** | Put water half – way into a glass beaker and add a Universal indicator. Cut a small piece of sodium metal using a knife, drop it into the beaker of water using a pair of tongs. Make observation. |
| **B** | Put water half – way into a water trough and add a Universal indicator. Put a small lamp of calcium metal into the water trough, and cover it with an inverted funnel and test tube as shown in the figure 8.6(a). Make observation. |
| **C** | Put water half – way into a glass beaker and add a Universal indicator. Cut small pieces of cleaned magnesium ribbon, drop them into the beaker of water using a pair of tongs. Make observation. |
| **D** | Put water half – way into a glass beaker and add a Universal indicator. Cut small pieces of zinc metal, drop them into the beaker of water using a pair of tongs. Make observation. |

**Discussion Questions:**

a) Record your experimental observations made in the table below.

| Experiment | Observation(s) |
|---|---|
| **A** | |
| **B** | |
| **C** | |
| **D** | |

### 8.7. Reactions of metals with steam

It will be remembered that the metals which don't react with cold nor hot water, react with only steam to form **metal oxides** and hydrogen gas after strong heating of the metals. These metals include magnesium, zinc, iron, aluminum, and lead.

**ACTIVITY:8.7(a)**

**What you need:**

Clean magnesium ribbon, Aluminium metal, Zinc metal, hard test tube, heat source, water, mineral wool (cotton wool), stand and a clamp.

**What to do:**

In groups, carryout the following investigations to find out the chemical reactions of steam with metals. Share and compare your findings with the rest of the class.

**Treat your experiments as follows:**

| Experiment | Activity |
|---|---|
| **A** | Soak the cotton wool in water and insert it at the bottom of hard test tube, put it horizontally on a stand clamp. Coil a clean piece of magnesium ribbon and place it in the middle of the hard test tube as shown in the figure 8.6(b). Heat strongly both the soaked cotton wool and magnesium ribbon and make observation. |
| **B** | Repeat the procedure in experiment A with Zinc metals. Make observation |

**Discussion Questions:**

b) Record your experimental observations made in the table below.

| Experiment | Observation(s) |
|---|---|
| **A** | |
| **B** | |

**What you may need to know when water (cold or steam) reacts with metals**

| Reaction with Cold water (*l*) | Reaction with Steam (*g*) |
|---|---|
| **Sodium**, melts vigorously forming a silvery ball and darts on the water surface with a hissing sound,which is hydrogen gas and a solution that turns red litmus paper blue. | This reaction is very risky since it involves explosions with flame and heat. |
| **Potassium**, ignites vigorously with a liliac purple flame, with a hissing sound and a solution which turns red litmus paper blue. | This reaction shouldn't be tried nor conducted since it involves rapid explosion with flame and heat. |
| Clean **magnesium** ribbon react slowly with cold water forming a solution that turns redlitmus blue. | Heated magnesium reacts with steam forming white ash (powder) and hydrogen gas |
| **Calcium**, reacts with water to produce bubbles of a colourless gas and a solution which turns red litmus paper blue. | This reaction is explosive |
| **Zinc** metal does not react with cold water | It reacts with steam when heated forming zinc oxide as a yellow solid when hot to white when cold and hydrogen gas |
| **Aluminium** metal does not react with cold water | It reacts with steam when heated forming aluminium oxide and hydrogen gas |
| **Iron** metal does not react with cold water | Heated red hot iron metal reacts with steam forming a black solid of tri – iron tetra oxide and hydrogen gas |

## 8.8. Importance of water

Water is essential for the survival of living organisms and has a number of importance it plays in life. These include:

**1)** It is a medium for many biological processes in the body of living organisms.
**2)** Water is used in the production of renewable energy such as hydroelectric power and cooling systems.
**3)** Water is home, supporting aquatic life, and maintaining a stable ecosystem and regulation of water cycle.
**4)** Water is important for irrigation, crop growth and livestock production.
**5)** Water is very in most domestic activities such as washing, drinking, bathing, making it vitals in most homes.
**6)** Water plays a role of being a Universal solvent, allowing many biological and chemical processes to occur to bring about change of products.

## 8.9. Causes, Effects and Measures of water pollution

| Cause | Effects | Measures taken |
|---|---|---|

| | | |
|---|---|---|
| 1) **Industrial effluent**: Are liquid wastes discharged from industries. | They contain toxic metals such as lead, cyanide and mercury that kill aquatic life and human being when eaten | Encouraging all industries to treat effluent before they are released into the environment. |
| 2) **Hot waste water,** produced from industrial cooling system | Produces waste water with high temperatures when lowers the amount of dissolved oxygen in water bodies, causing suffocation and death of aquatic life | Encouraging all industries to treat and cool waste water before they are released into water bodies. |
| **3) Oil spills;** from tankers, sub – marines, ships or oil leakages from pipelines | They prevent light and oxygen from penetrating into the water bodies, affecting vision and gaseous exchange of aquatic life | Encouraging periodic repair and checks of the leaking pipelines and sub -marines |
| **4) Municipal wastes**; from fiscal wastes, waste water from bathrooms, kitchen, detergents and fertilizers | They cause excessive enrichment of nutrients and excessive growth of **algal bloom** through a process called **Eutrophication**, which lowers the bio – oxygen demand (BOD) of aquatic life causing death and excessive growth of algae. | Encouraging all municipal wastes to be passed through pipelines into sewage treatment plant. |
| **5) Landfills and trash**, from plastic waste, garbage and kitchen refuse. | They contaminate both the surface and underground water, making it unsafe for use | Encouraging proper waste management such as garbage disposal, recycling plant, creating public awareness. |

**8.10. Water purification**

Water purification involves the following stages:

**Stage 1: Screening:**

The solid particles coming with raw water are screened by protective bars to screen and remove all visible solid particles.

**Stage 2: Coagulation (Flocculation)**

The particles free – water is allowed into coagulation chamber which contains coagulants such as aluminium sulphate to remove tiny particles that forms larger coagulants (Flocculants), suspended on water surface as **sludge**.

**Stage 3: Filtration**

The coagulated water is then passed through various filtration layers made of sand, gravels and charcoal, to remove tiny particles, coagulants and some chemicals.

**Stage 4: Disinfection:**

The chlorine is then added to the filtered water, to kill all harmful micro – organisms found in the water, followed by addition of fluorides to correct water taste for human consumption by providing a component for proper dental growth.

**Stage 5: pH correction:**

The chlorinated and fluorinated water is then corrected by adding lime in case the pH is below 7. It also reduces the risk of pipe corrosion during distribution.

### 8.11. Sewage treatment

We always use water daily in our bathrooms, laundry, kitchen and toilets. They produce waste water and fiscal wastes including those industrial effluent from industries. Where do they go? How can they be converted into clean water and recycled? There must be pipelines that channel them into the sewage treatment plants just like the way pure water is connected to your homes.

**Sewage** Refers to waste water from toilets, bathrooms and kitchen.

Sewage treatment involves the following steps:

**Step 1: Screening:**

Here sewage is allowed to pass through the screen chamber, to remove grit, sand and other solid materials as the liquid materials called the **influent** pass through.

**Step 2: Sedimentation:**

The sewage then passes into a sedimentation tank, where the remaining solid part (**sludge**) settle at the bottom of the tank, and the liquid part (**effluent)** of the sewage is on top of the tank.

**Step 3: Aeration:**

The **sludge** is then allowed into the **digester** tank which contains bacteria that aid in the digestion and decomposition of harmful substances such as ammonia to nitrates, hydrogen sulphide to water and sulphates.

**Step 4: Treatment**

The **effluent** from the sedimentation tank is pumped into the treatment tank to treat the waste water and to allow any remaining organic sediment to flow out of water.

**Step 5: Disinfection:**

Chlorine is added into the waste water, to kill any remaining bacteria and any other harmful microbes.

**Step 6: Analysis and testing:**

Waste water is then tested and analyzed to check the levels of pH, ammonia, nitrates, phosphates, bacterial levels before releasing them.

**Step 7: Effluent disposal:**

After meeting all the required specifications, clean waste water is reintroduced into the main water body or stream.

### 8.12. WATER CYCLE: What is water cycle? How is water recycled?

In this section, you will remember that water exist in all the three states of matter, solid, liquid and vapour (gas). Whenever water gains or loses heat, it transforms itself in all the three states of matter, this helps water recycle itself.

**ACTIVITY: 8.9(d) To find out the processes involved in water cycle.**

**What you need:**

A smartphone, or computer for internet, manila paper, marker pens, pencils and ruler.

**What to do:**

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1. In groups, go to the computer library or use your smartphones to research about water cycle and processes involved
2. Watch the uploaded pictures of the processes that is involved in water cycle.
3. Draw and label all processes involved in water cycle in the manila paper.
4. Compare and share your findings with the rest of the class.
5. Present your work to the rest of the class.

**QUICK QUESTIONS:**

| | |
|---|---|
| Water cycle is also known as Hydrological cycle.<br>a) Define the following terms<br>**(i)** Hydrological cycle.<br>**(ii)** Precipitation.<br>(iii) Evaporation.<br>**(iv)** Condensation.<br>**(v)** Transpiration. | b) Explain how each of the above processes aids the process of water cycle.<br>c) Explain how some of these human activities affect the process of water cycle.<br>**(i)** Deforestation:<br>**(ii)** Wetland drainage.<br>**(iii)** Land reclamation.<br>**(iv)** Dam construction. |

### 8.13. Sample of Activity of Integration

**SCENARIO:** Most wetlands around us have been destroyed with intension of searching land for settlement, sand mining, agriculture and setting up factories and industries. This is a growing problem to the country's total precipitation collected per annum. This effect has resulted into changes in the country climate and rainfall formation. This has caused the Government to set an autonomous body, National Environmental Management Authorities, NEMA as a body responsible for monitoring and enforcing environmental laws through protection and conservation of natural resources. They are organizing a radio talk show nationwide.

**TASKS**:

As a student who has understood the value of water as part of natural resources, the need to protect and conserve it.

Write a report to the locals in your community explaining the reasons why the government through ***NEMA*** is against the use of wetland using one of the radio stations in your locality.

## CHAPTER 9: ROCKS AND MINERALS

K,

IGNEOUS ROCK

METAMORPHIC ROCK

SEDIMENTARY ROCK

| Key words | Learning Outcomes (LOs) |
|---|---|
| ☐ Rocks<br>☐ Minerals igneous rocks<br>☐ Igneous rocks<br>☐ Sedimentary rocks<br>☐ Metamorphic rocks<br>☐ Weathering of rocks | By the end of this chapter, you should be able to:<br>a) Understand how igneous, sedimentary and metamorphic rocks are formed, that they are made up of minerals, and that some minerals are useful.<br>b) Identify the physical properties of rocks and distinguish between the different types.<br>c) Understand the process of weathering and how weathered rock particles form the basis of soil. |

**COMPETENCY:** Learner appreciates that rocks are composed of different minerals and these determine the properties of rocks.

## 9.1. Introduction:

The Universe is composed of earth and space. The Earth in which we live is made up of rocks. The studies of rocks and minerals is called **Geology**.

## 9.2. Rocks and minerals

**Rocks** are naturally occurring solid aggregate of one or more mineral substances. They may have one or more mineral substances combined by physical means.

**Minerals:** Are naturally occurring inorganic or organic substances.

Inorganic minerals constitute mainly of chemical elements such as metals like aluminium, copper, magnesium, uranium, sodium, potassium, silicon, zinc, iron etc.

Organic minerals, consist of crude oils that are trapped in porous rocks like sandstone.

## 9.3. Classification of rocks

Rocks are placed mainly into three classes. **(1)** Igneous rocks **(2)** Sedimentary rocks and **(3)** Metamorphic rocks. Their types depend on the process of their formation.

### a) Igneous rocks:

Are rocks formed by cooling and solidification of molten magma or lava formed from volcanic activities. They are classified into two forms.

**Intrusive Igneous rocks** Are rocks formed when the molten magma cools and solidifies below the Earth's surface.

**Examples**: Granite, Gabbro, Pegmatite, Obsidian

**Extrusive Igneous rocks** Are rocks formed when the molten magma cools and solidifies above the Earth's surface.

**Examples:** Basalt, Rhyolite, Andesite, Scoria.

**b) Sedimentary rocks**

Are rocks formed from the accumulation and compression of minerals and organic particles, such as sand, silt and clay. Examples include Shale, Limestone, and Sandstone, conglomerate

**c) Metamorphic rocks:**

Are rocks formed when the existing rocks are subjected to high temperatures and pressures, causing changes in their mineral composition and structure. They may also be formed when the existing rocks are exposed to heat and fluids from molten magma.

**Examples** of metamorphic rocks include Marble, Sale, Quartzite

## 9.4. Physical properties of rocks

| Property | General characteristics of | | |
|---|---|---|---|
| | **Igneous rocks** | **Sedimentary rocks** | **Metamorphic rocks** |
| Colour of the rock | Light coloured rocks<br>Dark or black coloured rocks<br>Translucent with glass-like appearance | Colourless or light-coloured rocks<br>Dark or black coloured rocks<br>Translucent with glass-like appearance | Colourless or light-coloured rocks<br>Dark or black coloured rocks<br>Translucent with glass-like appearance |
| Texture of rocks | Rocks with rough surfaces<br>Rocks with smooth surfaces | Rocks with coarse surfaces<br>Rocks with fine surfaces | Rocks with coarse surfaces<br>Rocks with fine surfaces |
| Particle size of rocks | Large sized particle crystals<br>Small sized particle crystals. | Large sized particle crystals<br>Small sized particle crystals. | Large sized particle crystals<br>Small sized particle crystals. |
| Methods of rock formation | Cooling and solidification of molten magma<br>Intrusive (when magma solidifies from inside the earth's surface and extrusive (when magma solidifies above the earth's surface | Rocks formed by mechanical means<br>Rocks formed by deposition of organic matter.<br>Rocks formed by chemical means. | Formed from the aggregates of pre-existing rocks exerted to high temperatures and pressures.<br>Formed when the existing rocks dissolve in the fluids of molten magma |

## 9.5. Rock cycle

**Rocks** exist in the t**wo** main states of matter, solid and liquid. Whenever **rock** gains or loses heat at varying pressures, it transforms itself in the t**wo** major states of matter, this helps **rock** recycle itself.

**ACTIVITY: 9.5(a)**

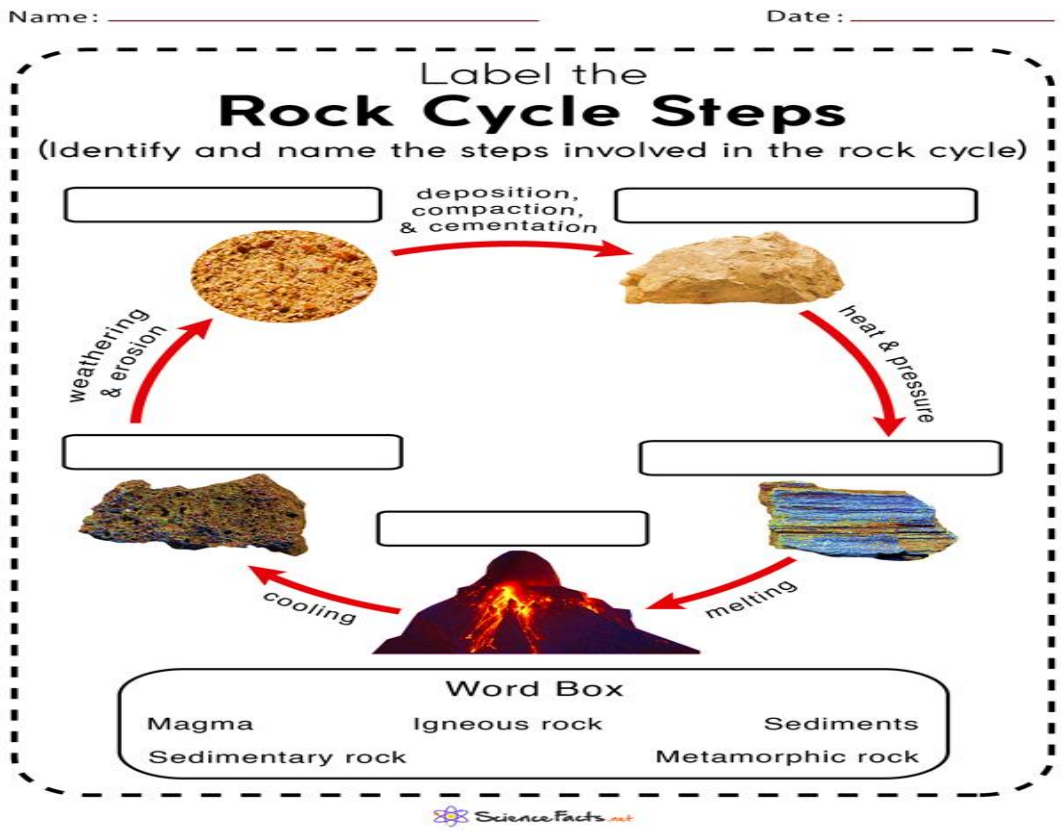
**What you need:**

A smartphone, or computer, manila paper, marker pens, pencils and ruler.

**What to do:**

1. In groups, go to the computer library or use your smartphones to research about rock cycle and steps involved. View the uploaded pictures on internet showing names and the steps involved in rock cycle.

2. Use it to answer the steps in the blank boxes involved in rock cycle, in the manila paper.
3. Compare and share your findings with the rest of the class. Present your work to the rest of the class




## 9.6. Dichotomous key of Rocks

**ACTIVITY: (h) Constructing a dichotomous key of rocks using their characteristics.**

**What you need:** Pictures of different types of rocks. *Table 1*

| | | | |
|---|---|---|---|
| **Limestone rock** | **Pumice rock** | **Marble rock** | **Basalt rock** |

| | | | |
|---|---|---|---|
| **Gabbro rock** | **Gneiss rock** | **Conglomerate** | **Kaolinite -claystone** |

The rocks given in the above pictures, have been grouped into igneous, sedimentary and metamorphic rocks respectively.

**What to do**

1. In groups, construct a dichotomous key using the following characteristics of rocks.
2. Use the flowchart in the table below to construct a dichotomous key.

**Flow chart showing the Characteristics of different types of rocks.** ***Table 2***

| | | |
|---|---|---|
| 1. Types of rocks | **(a)** | Igneous rocks (Gabbro, Basalt) ------(2) |
| | **(b)** | Sedimentary rocks (conglomerate, limestone) and Metamorphic rocks (Gneiss, Marble) -------(3) |
| 2. Textures of rocks | (a) | Igneous rocks with smooth surfaces. (**basalt**) |
| | (b) | Igneous rocks with rough surfaces (**gabbro**) |
| 3. Hardness of rocks | (a) | Sedimentary rocks with soft layered crystals ---(4) |
| | (b) | Metamorphic rocks with hard layered crystals ---(5) |
| 4. Coarseness of grained Particle size | (a) | Particle size ranges from 0.2mm (for fine grained) to 2.22mm (for coarse grained) (**limestone**) |
| | (b) | Particle size ranges from 2mm (for pebble) to 256mm (for boulder) (**conglomerate**) |
| 5. Foliation of rocks | (a) | Non – foliated (non-banded) layered metamorphic rocks (**Marble**) |
| | (b) | Foliated (banded) layered metamorphic rocks (**Gneiss**) |

**Types, locations and formation**

| Types of rocks and examples | How are they formed | Location |
|---|---|---|
| **1.Igneous rocks:** Gabbro, Granite, Quartz, Pumice, Basalt, Obsidian, pegmatite. | Formed from molten magma or lava that cool down and solidifies. | Areas of volcanic activity |
| **2.Sedimentary rocks:** Limestone, sandstone, Dolomite, shale, chalk Conglomerate | Formed from accumulation of rock particles such as sand, silt, clay | Areas where there is water such as lake, rivers, oceans |
| **3.Metamorphic rocks:** Marble, Gneiss, Slate, Schist, Quartzite, magnetite | Formed when the existing rocks on exposure to heat, pressure or molten magma | Areas with tectonic activity |

**9.7. Minerals**

| Class of rocks from which the mineral is obtained. | Types of rocks with minerals | Minerals found |
|---|---|---|
| **(a)** Igneous rocks | Granite | Quartz |
| **(b)** Sedimentary rocks | Sandstone | |
| **(c)** Metamorphic rocks | Quartzite | |
| | Schist and magnetite | Iron |
| | Gneiss | Feldspar |
| **(d)** Sedimentary rocks | Sandstone | |
| | Limestone, chalk | Calcium carbonate |
| **(f)** Metamorphic rocks | Marble | |
| | Schist and Gneiss | Muscovite |
| | | Mica |

### 9.8. Weathering of rocks and soil formation

These processes of weathering placed into three groups: (1) Mechanical (Physical) (2) Chemical and (3) Biological weathering. **Table 1**

| | |
|---|---|
| Frost action | Water seeps into cracks into rocks, freezes and expands, breaking off pieces of rock. As ice thaws, the rock fragments are left behind, beginning the process of soli formation. |
| Abrasive action of wind | Wind carries particles like sand and dust, which rub against rocks, wearing them down and breaking them into smaller particles. |
| Thermal contraction and expansion | the rhythmic contraction and expansion of rocks when heated and cooled, causing cracks and fractures. This repeated process, breaks down the rocks into smaller fragments. |
| `action of acid rain on rocks | Acid rain reacts with minerals in the rocks, dissolving and breaking them down into rock fragments |
| Oxidation | Oxygen reacts with minerals in the rocks, causing them to break down and release minerals which form part soil particles |
| Hydrolysis | Water reacts with minerals in the rocks, causing them to break down and release minerals which form part soil particles |
| Action of plant roots | Plant roots grow into cracks and crevices in rocks, exerting pressure and breaking off pieces of rocks as they grow. |
| Burrowing action of animals | Animals like worms, ants and rodents burrow into rocks, breaking off pieces of rocks and carrying them away, mixing them with other minerals to form soil. |

### 9.9. Sample of Activity of Integration

**Scenario:**

Rocks and minerals are some of the few non – renewable natural resources. The curiosity of man to discover what rocks contain, has resulted into extraction of valuable minerals

elements and additional roles they play in the housing, dam, bridges, road and motor constructions.

**Task:**

As a young vibrant geologist who has not only understood rocks and minerals but also their day – to -day importance they play in our society.

Write a brief report explaining how the properties of rocks and minerals may affect the choice of their demand in the following construction sites.

(a) House foundation, recreations and sceneries.

(b) Bridges, dam and road construction.

**9.10. END OF CHAPTER SUMARY**

Rocks are naturally occurring substances made of minerals. Rocks may constitute of only one or more types of minerals physically combined.

Minerals are naturally occurring inorganic or organic substances found beneath the Earth's surface. Inorganic minerals are mainly chemical elements such as metals like aluminium, iron, copper, magnesium, mercury, uranium, sodium, potassium, silicon, zinc or non – metals such as carbon -diamond and carbon – graphite etc. organic minerals are mainly oils inform of crude oils trapped in porous rocks, such as sandstone or limestone beneath sedimentary basins.

Igneous, sedimentary and metamorphic rocks are the classes of rocks. Granite, Gabbro, slate, shale, Gneiss, Marble conglomerate, Quartzite, are some of the examples.

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